

SESSION ON OCEAN ENGINEERING

Chairman: Mr. M.M.Nielsen

*Presidium of the Session*

Discussion of the Report and Draft Recommendations of the Committee on Ocean Engineering

I. DISCUSSIONS

E.HUSE - Norwegian Hydrodynamic Laboratories, Trondheim, Norway.

First of all, let me express my appreciation for the committee report with all its valuable information. It proves that it was a wise decision to establish an Ocean Engineering Committee at the last ITTC.

My few comments are:

1. In its evaluation of methods for measuring model motions the report deals with "non-contacting" systems as well as "contacting"

(electro-mechanical) ones. It leaves the impression that the main disadvantage of the latter is the unwanted inertia forces acting on the model. I agree that they can be of importance. However they are under some sort of control since their magnitude can be evaluated. In my opinion the frictional damping introduced by such systems, not mentioned in the report, is much more dangerous. My experience is that the motion amplitude of floating models moving at resonance and with small hydrodynamic

damping can be dramatically changed by such frictional damping.

2. On page 316 is said that when testing SPM systems it can be essential to model the structural damping of the hawser. What is the Committee's consideration or reference for this statement? In case it is correct, I think the most practical way of modelling hawser structural damping as well as elasticity will be by application of a computer-controlled winch on the ship model.

3. In item 3 of your Recommendations I suggest that you include data "presentation and reporting" in addition to acquisition and analysis.

V.N. TRESHCHEVSKY, Krylov Shipbuilding Research Institute, Leningrad, USSR

AERODYNAMIC FACTORS IN THE OCEAN ENGINEERING RESEARCH

The role of aerodynamic factors in the balance of forces acting on a floating construction can vary within a wide range. For displacing vessels in calm sea the air flow around the above-water part of the ship causes some additional resistance, which is usually rather small. For the vessels of the same type, a gust of cross direction can make aerodynamic forces the decisive factor of ship's dynamics. For high-speed vessels, especially for amphibious air cushion craft, which are characterized by high speed, small hydrodynamic contact, and considerable wind-affected surface, the role of the aerodynamic forces is comparable with that of the hydrodynamic factors.

Ocean engineering devices present a good example of floating con-

structions whose dynamics to a great degree depends on the forces of aerodynamic origin. At the same time the correct determination of these forces, both theoretically and experimentally, often can not be achieved using the standart methods due to the peculiarities of the ocean engineering constructions' aerodynamics. These peculiar features result from their architecture which is rather unusual for aerodynamics. Such constructions present a combination of box-shaped (platform, superstructures) and cylinder-shaped elements. The Ocean Engineering Committee Report contains some interesting data on the hydrodynamics of the underwater sections of ocean engineering constructions. Of interest are also the data concerning the upper sections of these structures. Some examples are given below*.

1. The aerodynamics of a platform is characterized by formation of a stall zone along the windward side of the platform's deck. This zone covers a considerable length of the platform. Part of the superstructures get within the separated flow. The result is that their resistance becomes lower, in comparison

with the case when they are under the direct flow, and it depends largely on the position of these structures along the platform. An unusual feature appears due to the flow along the upper and lower sides of the platform near the water surface. This brings up a lift which is larger than the drag and causes an additional pitching moment of a considerable value.

* Based on the results of the investigations carried out at the Institute's Wind Tunnel Laboratory

2. As to the girder constructions, the peculiarity of their wind resistance is its dependence on the interference of the elements. For example, the drag coefficient of a cylinder located behind another cylinder of the same diameter may change greatly as compared with the direct flow. The resistance can even become negative (suction) when the cylinders are located close to each other. Another important factor on the aerodynamics of the girder structures is the Reynolds number. Its influence can be different for the cylinder-shaped elements located in the direct flow and located behind the others. With the certain Re values, the wake effect may not display itself. This can lead to big mistakes in strength calculations.

The actual speeds of wind, including that of the gusts, which are directly used in the ocean engineering resistance and dynamics calculations are not yet adequately studied.

The above given examples show the difficulty of both theoretical and experimental determining of the aerodynamic characteristics of the ocean engineering structures. The conclusion which follows the above described is that the aspects of the aerodynamics of various floating constructions should permanently be within the sphere of interest of the Ocean Engineering Committee, as well as of the Panel on High-Speed Marine Vessels and probably some other ITTC Committees.

T.I.TACHIBANA, M.A.REIS- Instituto de Pesquisas Tecnologicas Cidade Universitaria, Sao Paulo S.P., Brazilia.

A METEO-OCEANOGRAPHIC DATA ACQUISITION SYSTEM FOR THE BRASILIAN COAST

SORD - Ship and Ocean Research Division - IPT and the Compagnie Generale DORIS are executing a project on meteo-oceanographic data acquisition for Brazilian Offshore development. The project shall begin during this year and will continue for approximately 7 years.

The system will consist of some offshore stations which can be relocated, and an onshore data management base at SORD-IPT in Sao Paulo.

1 - OFFSHORE STATIONS

Each offshore station will consist of a semi-submersible buoy for collecting data near the water surface and in the atmosphere, and of an oceanographic sensors' line moored near the buoy for the other measurements in water.

1.1 - SEMI-SUBMERSIBLE BUOYS

The buoy has sensors in duplicate (Figures 1-3) and an Argos Satellite transmission system for reliable transmission of data for diagnostic and auto control to Sao Paulo onshore base, twice a day.

The systems installed in the buoy shall be:

- . able to resist and to be stable up to 16 m wave heights and up to 100 m - water depth;
- . equipped with a computer system for data acquisition providing a large storage capability (1600 BPI-

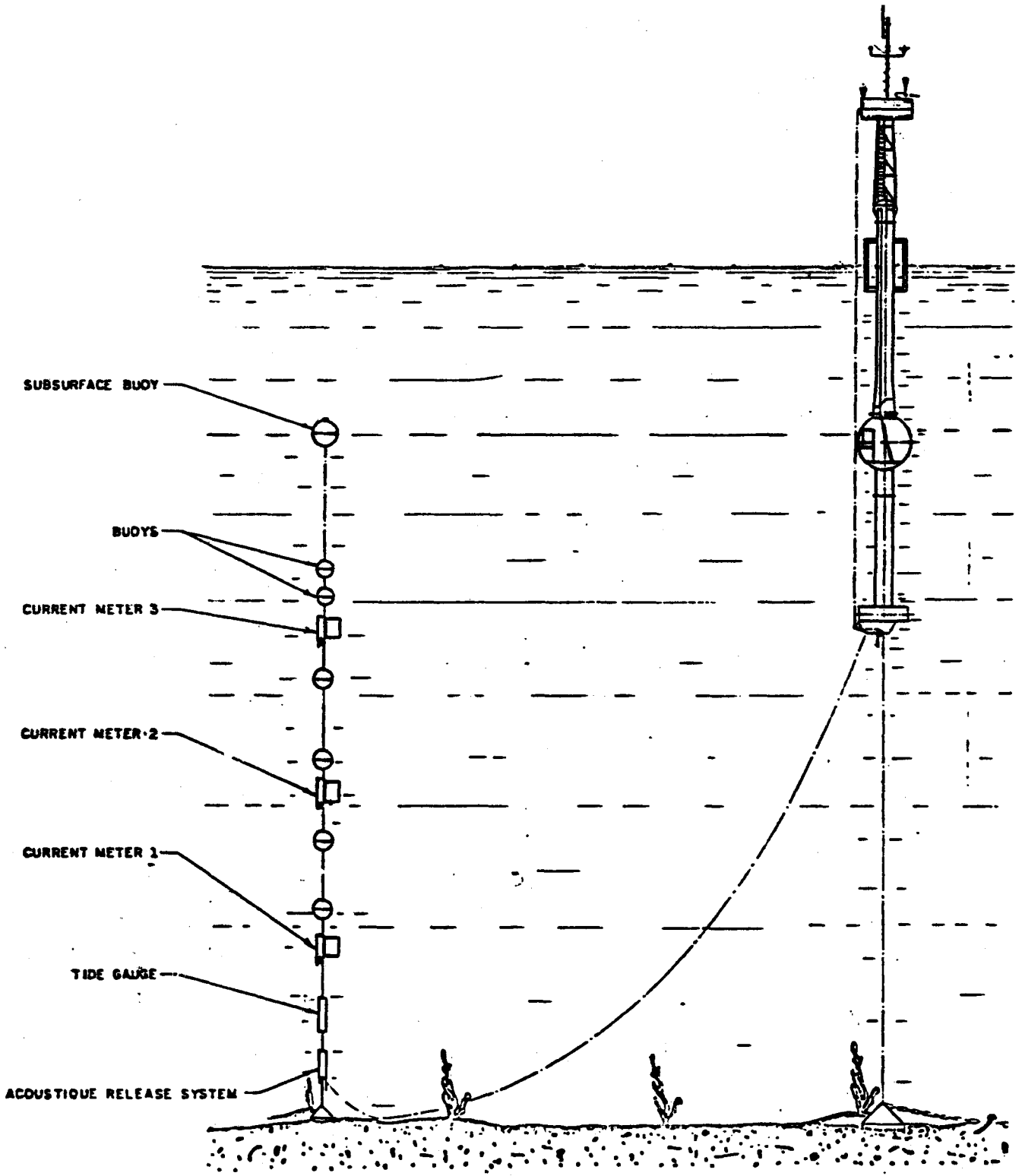


Fig.1. General Arrangement of the System

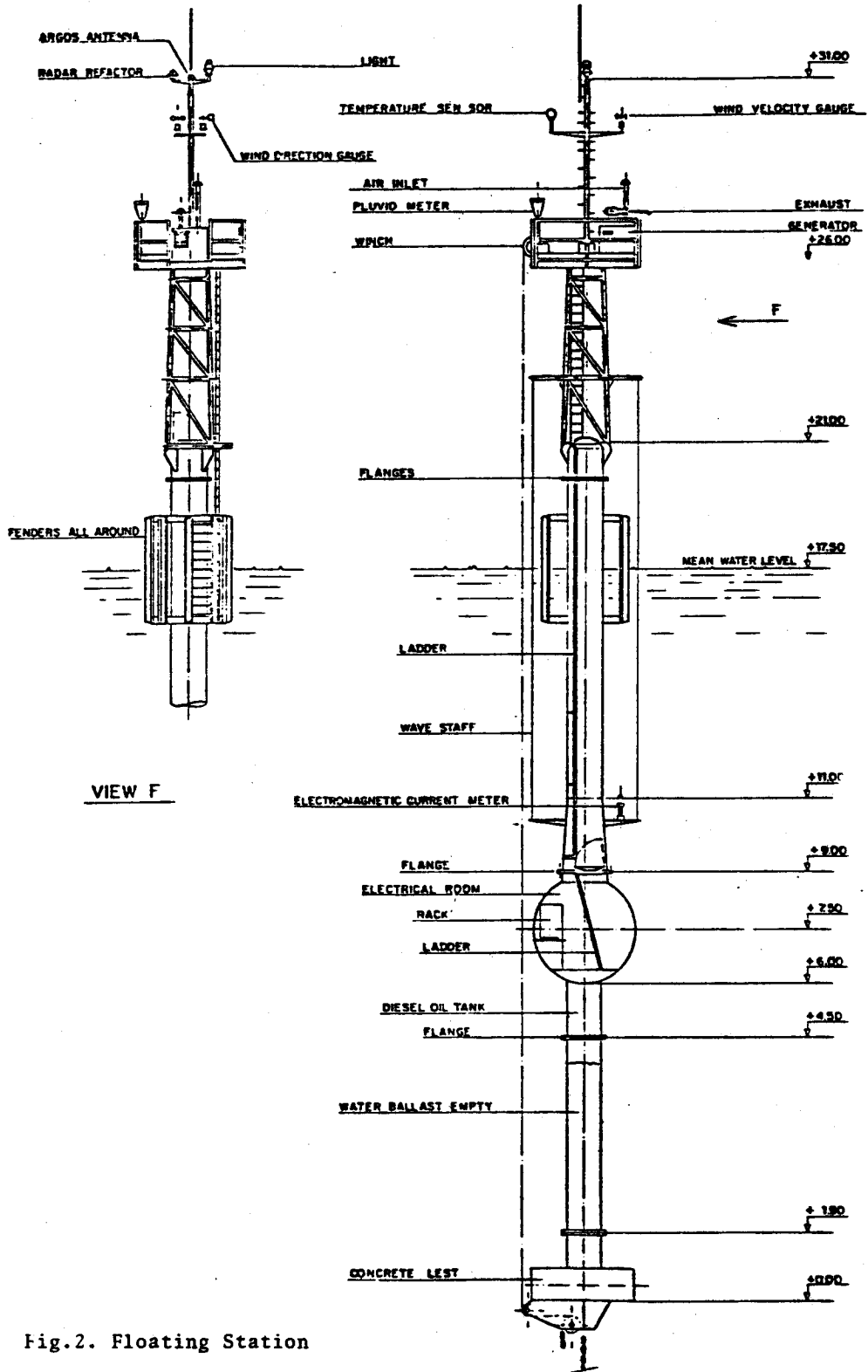
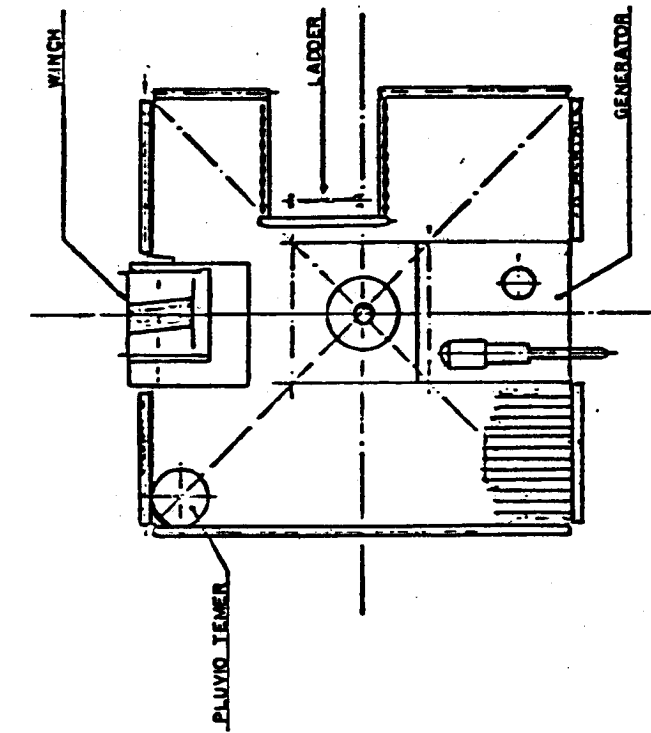
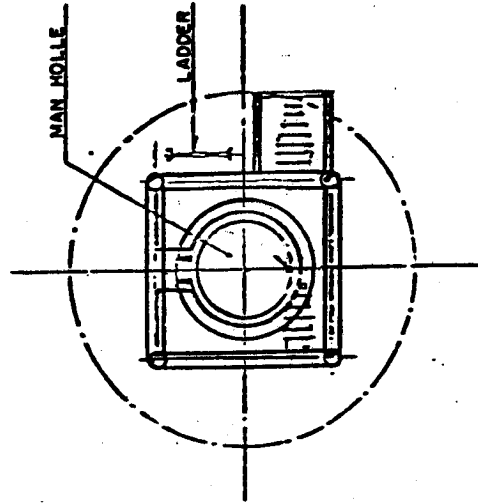


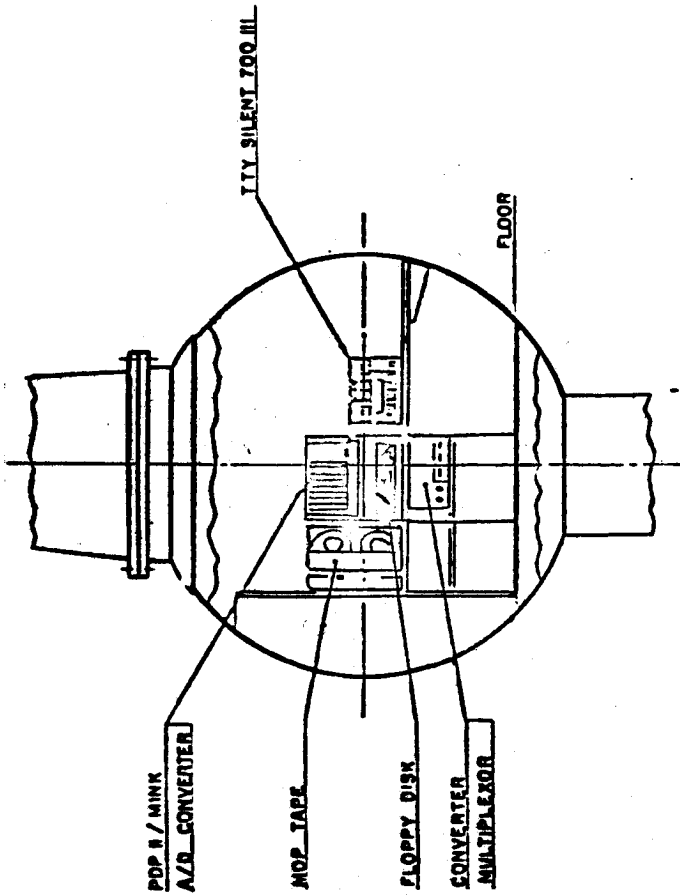
Fig.2. Floating Station



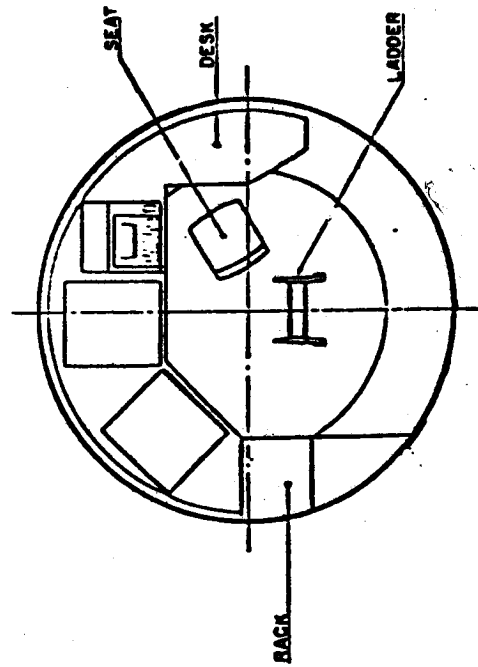
PLAN VIEW LEVEL 26.00



PLAN VIEW LEVEL 21.00



ELECTRICAL ROOM



SECTION AA

Fig. 2a. Central Body

DATA ACQUISITION ORGANISATION

PARAMETERS	NUMBER CHANNEL	SAMPLE RATE	SAMPLE DURATION	SAMPLE INTERVAL	NUMBER OF DATA PER CHANNEL EACH CYCLE	TOTAL/DAY
SWELL HEIGHT	H 1	2 Hz	20'	3 Hours	2 400	19 200
CURRENT METER ELECTROMAGNETIC	HX HY 2	2 Hz	20'	3 Hours	2 400	38 400
WIND SPEED DIRECTION	V D 2	2 Hz	10'	3 Hours	1 200	19 200
MEAN CURRENT SPEED DIRECTION	HX HY 2	0,5 Hz	10'	20'	1	144
MEAN WIND SPEED DIRECTION	V D 2	0,5 Hz	10'	20'	1	144
AIR TEMPERATURE	Ta 1	0,5 Hz	10'	20'	1	72
RAIN FALL	PL 1	1 time	20'	20'	1	72
AIR PRESSURE	Pat 1	1 time	-	20'	1	72
SEA TEMPERATURE	T 1	0,5 Hz	10'	20'	1	72
SALINITY	S 1	0,5 Hz	10'	20'	1	72
<u>OCEANOGRAPHIC BUOY INSTRUMENTATION</u>						
ACCELEROMETER	Z 1	2 Hz	20'	3 Hours	2 400	19 200
INCLINOMETER	X Y 2	1 Hz	20'		1	144
<u>SEPARATE CURRENT TIDE T/S/P ACQUISITION</u>						
CURRENT 1	2		10'	20'	1	144
T/S/P	3		10'	20'		216
CURRENT 2	2		10'	20'	1	144
T/S/P	3					216
TIDE	2		10'	20'	1	144
T/S/P	2					144

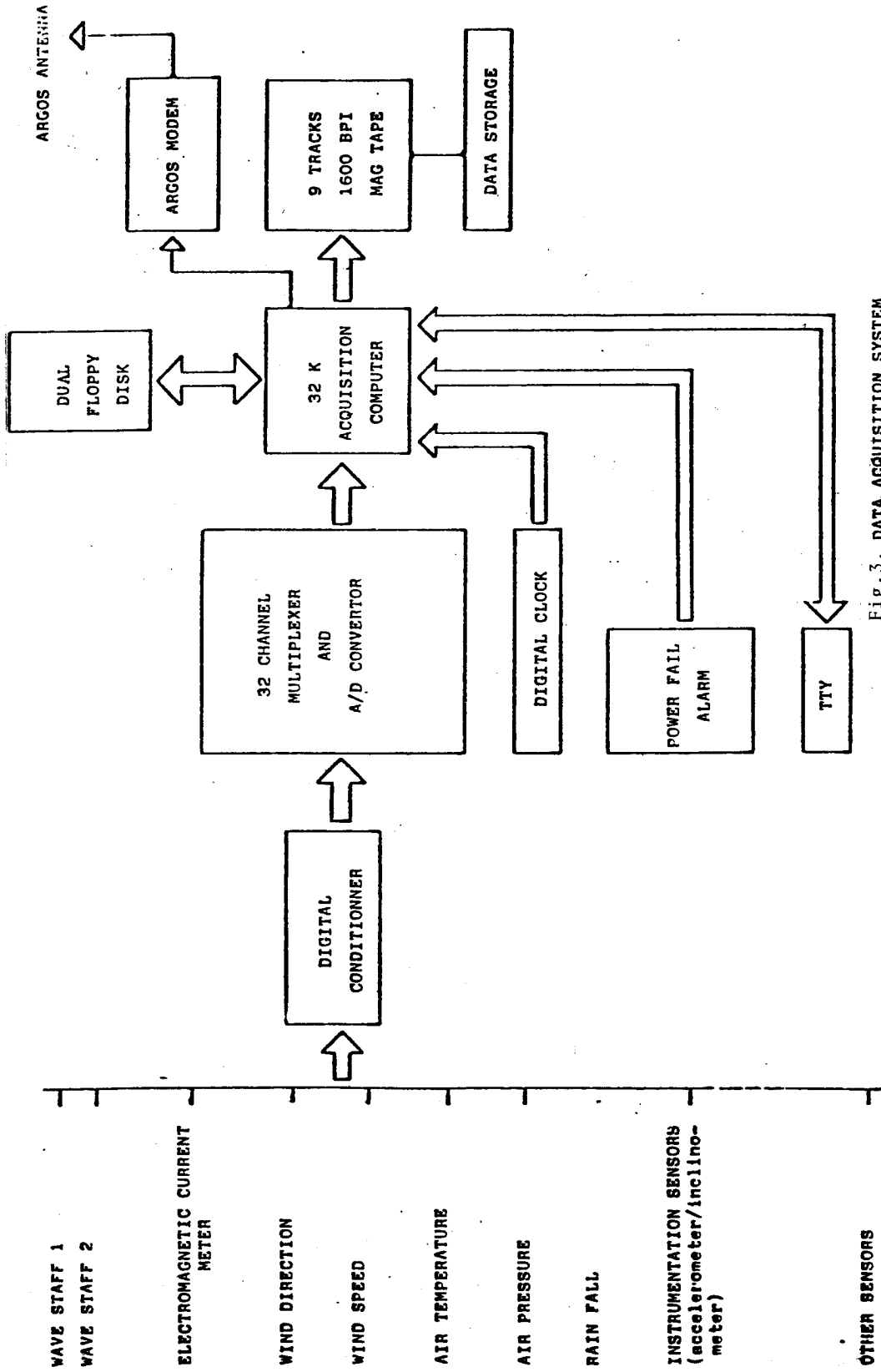
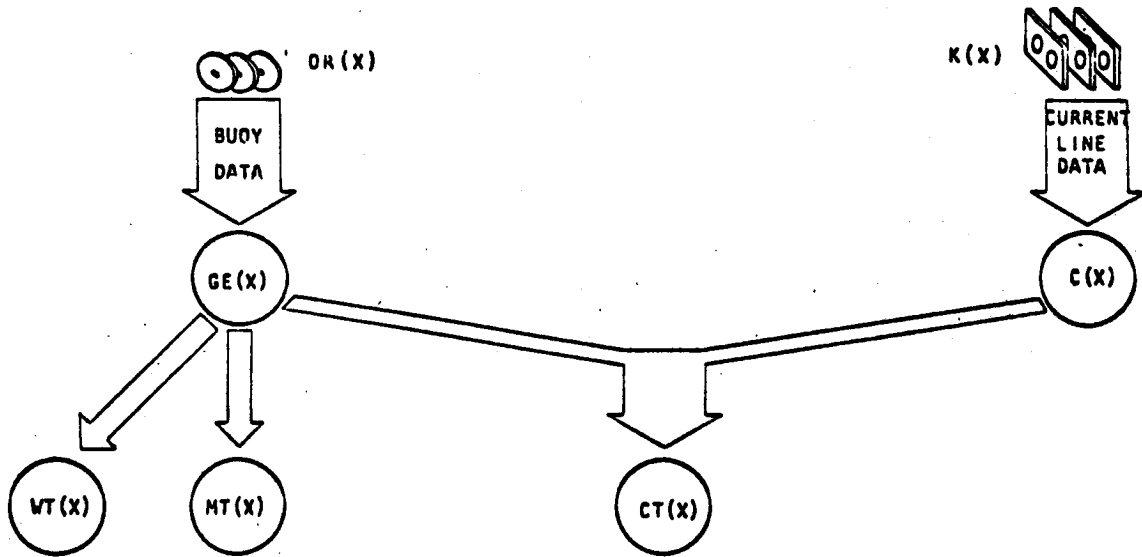


Fig. 3. DATA ACQUISITION SYSTEM



- GE(X) Monthly Data Tape - Generated - (BUOY)
- C (X) Monthly Data Tape - Generated - (CURRENT LINE)
- WT(X) Wave Data Tape
- MT(X) Meteo Data Tape
- CT(X) Current Tide Data Tape

Fig.3a. DATA MANAGEMENT ORGANISATION

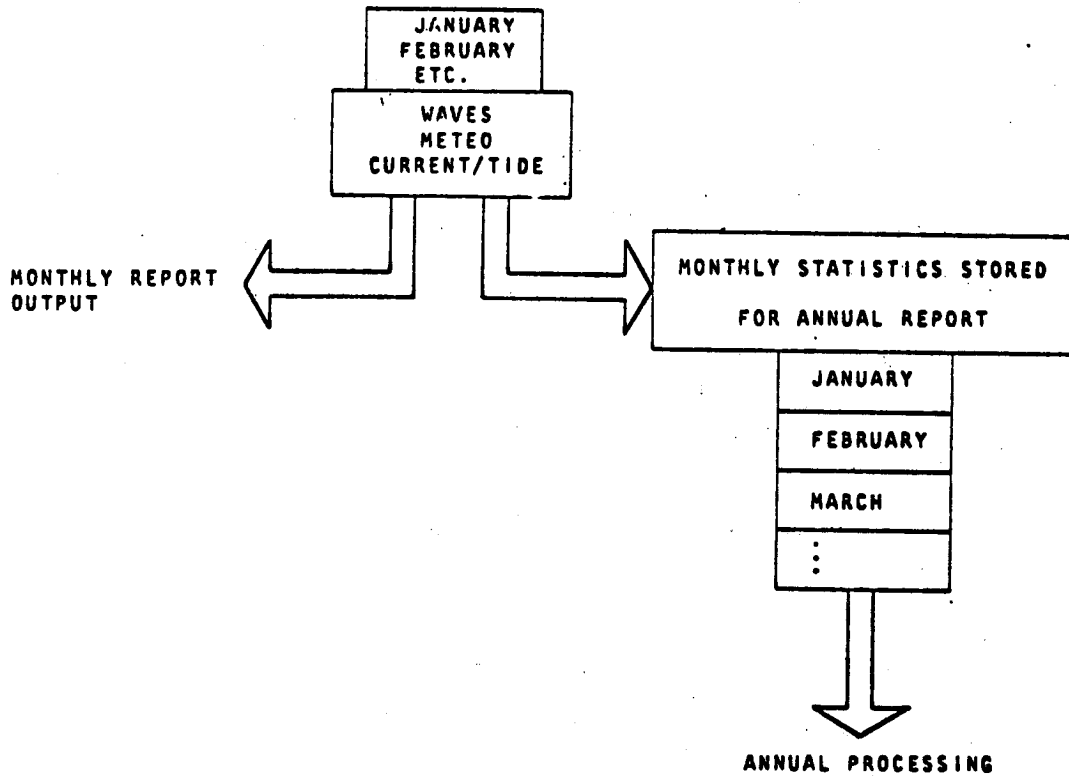


Fig.3b. ANNUAL STATISTICS AND RESULTS REPORT

9 tracks magnetic tape);

. capable of measuring quantities like: wave height, orbital velocities, pressure, temperature (air and water), wind velocity rainfall and humidity;

. able to correct sensors' data for buoy movements.

1.2. LINE OF OCEANOGRAPHIC SENSORS

The line of oceanographic sensors installed near the buoy will include self recording meters for current, tide, temperature and salinity (Fig.1).

2. DATA MANAGEMENT

The activities of the data management base in Sao Paulo will consist of 2 steps:

First: translation of data values including conversion to convenient units.

Second: generation of three kinds of data tapes:

. WT(X), where WT stands for "wave data tapes";

. MT(X), where MT stands for "meteorological data tapes";

. CT(X), where CT stands for "current data tapes", which includes current and all the remaining oceanographic data.

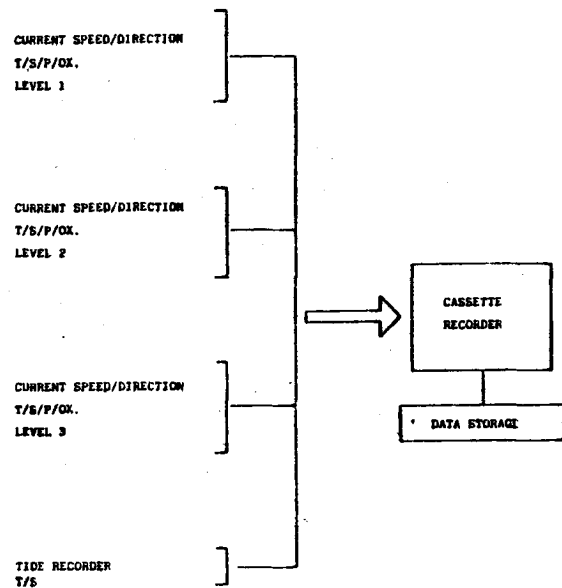


Fig.3c CURRENT-TIDE-WATER QUALITY
ACQUISITION SYSTEM

S.TAKEZAWA - National University of Yokohama, Japan

An Application of an Opto-Electronic System in a Model Experiment of an Off-Shore Structure.

Recently, a model experiment of an offshore structure was carried out at Y.N.U. (Yokohama National University) using an Opto-electronic system.

This "Opto-electronic measuring system" was completed recently in Japan. Although a new photoelectric semiconductive plane unit called Position Sensitive Detector (PSD) is used, the principle of measurement in this new system is the same as the well-known SELSPOT system and the specification of that is also similar.

At the model experiment in moored condition, the wide visible field of camera is not necessary,

because the drifts on horizontal motions are small. Therefore it is easy to apply this new system with high precision. Then a trial of this system was executed to measure the multi mode motions of a moored semisubmersible offshore structure in waves.

In this condition this model was only moored with the four wires with a linear spring each. Moreover the experiments using both the ordinary mechanical measuring system and new one were carried out in order to check the results from this new system. The block diagram of the instrumentation is shown in Fig.1. As each target LED of this system has a direction, it is necessary the LED facing to the camera. The side camera (C_s) catches two LED (1S, 2S) in its vision and detects simultaneously co-ordinates of vertical plane of two points, this means that it measures the four time records $X1(t)$, $Z1(t)$, $X2(t)$ and $Z2(t)$, and heave, pitch, surge are obtained from these. In the same way, the front camera (C_f) detects four time records [$Y1(t)$, $Z1(t)$, $Y3(t)$ and $Z3(t)$] from two LED (1F, 3F), and heave, roll, sway are calculated from these. Totally only yaw is not measured in this experiment.

These output data were transformed into the motions at centre of gravity (G) by Analog Computers, and both transformed and raw data were recorded in Analog Data Recorder. Fig.2 shows the transformed time histories in a head Transient Water Wave (T.W.W.), and it shows the comparison with the records by the mechanical measuring system and the opto-electronic measuring system.

Consequently, on such simple cases the difference between the

two results was very small and it was clearly understood that satisfactory results were obtained by this new measuring system, and opto-electronic system have an advantage especially in measurements of the small angles.

Fig.3 shows a sample of the transfer function calculating from Fig.2. Certainly, good agreement exists between two measuring systems.

In oblique waves, surge and sway motions and drifts in respective direction were occurred simultaneously. There is a clear drop of the measuring accuracy of this system, because the distances (L) between LED and cameras change in a nonnegligible order. In practice, when L is sufficiently large, the influence due to ΔL (the variation of the distance (L)) can be neglected. In ordinary towing tanks, it is impossible to take the distances (L) satisfactorily large, so that precision of the record is initially defined by L .

In our moored experiments the maximum measuring error due to ΔL was about $\pm 1\%$.

In order to diminish its error, it is one of the methods that use the servo driven stand of camera to keep ΔL into zero, but there is an important demerit that this stand itself is expensive as well as the mechanical measuring system. On the other hand, in basics, it is possible to measure all six modes of motion at centre of gravity correctly detecting simultaneously each co-ordinate, $X(t)$, $Y(t)$ and $Z(t)$, more than three points using many LED. However practically these systems become very

complex and very expensive.

Consequently as shown in our trial, it is understood that the opto-electronic measuring system can be utilized practically even at such a tank of university where have a little budget, but measuring the large motions in six modes with the high precision is not easy.

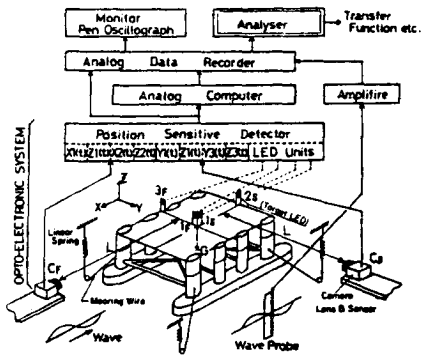


Fig.1 Block Diagram of the Instrumentation

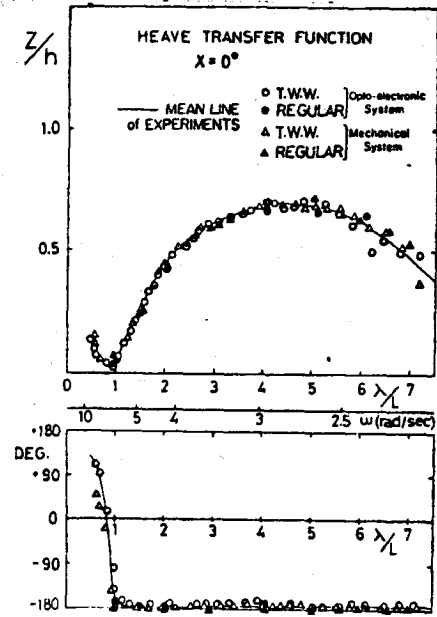


Fig.3 Sample of the Transfer Function

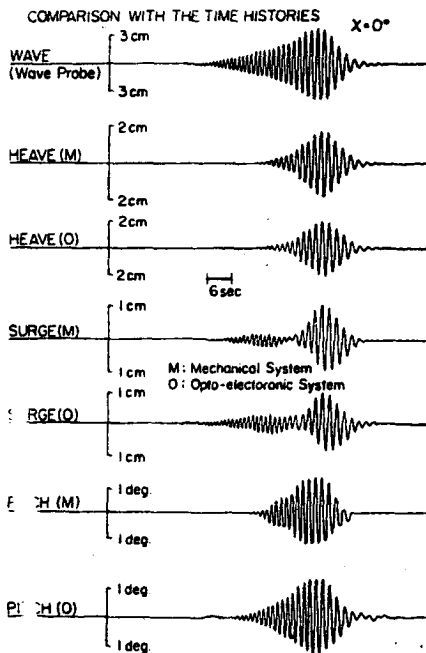


Fig 2 Comparison with the Time Histories

H.C.KIM - Korea Research Institute of Ship, Daejeon, South Korea

With regards to model testing on drilling rig-like structures although the Committee has pointed out the problems already, I would still like to emphasize the two difficulties - difficulties that are pertinent but seem beyond the reach of the solution, and would like once more the opinions and suggestions of those who have been in this business earlier.

We at the Ship Research Station of KIMM (former Korea Research Institute of Ships) are currently installing a wave maker in our 200x16 m towing tank, which is expected

to be in operation very soon for both ship models and for ocean engineering purposes.

For a drilling rig-like structure, however, even with a 1/10-scale model, which would be a respectful size that we can handle, the model scale effect with regards to Reynolds number would be serious. Referring now to the Committee report, Figs. 9 and 10 on p.339, the model Reynolds number would be at about 10^5 whereas the same for the full scale rig would be at about 10^6 or better, resulting in the steady state drag coefficient on pipe section to be about twice on the model and lift coefficient about six or seven times compared to the full scale. Of course, this is for a unit section on a steady state condition. In an actual model testing condition, the situation would become even worse to describe since the physical sections are mixed, and hence the drag and the lift.

We have, it seems, yet to develop what would be equivalent to "turbulent stimulators" and the "extrapolator" in this kind of model testing. Worst of all, such a possibility seem quite remote, if I may dare add.

Also with a drilling-rig like structure, particularly at the resonance, the magnitude of motions (heave or roll) is relatively large even with small exciting forces. And in such cases the simulation of damping, both the viscous originated mentioned above and also the instrument caused, would affect the final result a great deal. The order of damping that one has to be careful of in model testing in a drilling rig-like structure compared to a ship model far exceeds the present.

Experimental techniques and apparatus (namely use of a heave shaft and signal wires dangling from a model - note: the majority uses such method).

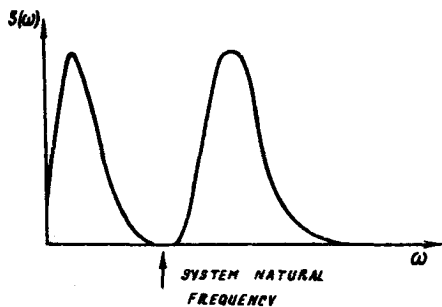
These two causes of possible experimental errors seem difficult to overcome. Bigger model would help but then how big can you get! Your suggestions would be most welcome and timely for us as we are about to start on this kind of experiment.

M.X.GU - China Ship Scientific Research Center, Wusih, Kiangsu, China

The work of the new Ocean Engineering Committee is to be congratulated in giving a good Survey of the Analytical tools and experimental methods applicable to this field. In China, since the development of offshore oil industry is very important, methods of computing and experimenting on slow drifting forces on moored ocean structures naturally come to the forefront in applied research. We have tried in CSSRC seakeeping basin, regular and irregular wave experiments on the longitudinal drifting force acting on a tanker model in headsea condition, as well as methods of computation of drifting forces using the CSSRC strip theory programme (essentially STF method) for computing the motions, and Pinkster or Faltinsen's method for integrating the second order forces along the hull. The tanker model, in the case of irregular waves, is held in position by a soft spring and a string whose combined spring constant yield a natural frequency for the whole spring-line-ship system corresponding to the "hollow" just between the first order sea

wave spectrum and the second order force spectrum/see diagram/. The period of return is 45 min in the tank, corresponding to about 4 hrs, reality. The 45 min record taken were divided into 20 intervals for statistical analysis and the mean of ensemble taken.

Instead of calculating the cross-bi-spectrum by double Fourier transform of the third moment, however, we calculated the cross-bi-spectrum directly by FFT from the wave and force time histories



$$S_{xxy}(\omega_1, \omega_2, T, \kappa) = \frac{1}{T} x_{\kappa}^*(\omega_1 T) x_{\kappa}^*(\omega_2, T) y_{\kappa}(\omega_1 + \omega_2, T),$$

where $x_{\kappa}(\omega, T) = \int_0^T x_{\kappa}(t) e^{-i\omega t} dt,$

$$y_{\kappa}(\omega, T) = \int_0^T [y_{\kappa}(t) - y_{\kappa}(t)] e^{-i\omega t} dt,$$

$x_{\kappa}(t)$ - wave time history

$y_{\kappa}(t)$ - force time history

It may be proved that, the cross-bi-spectrum

$$S_{xxy}(\omega_1, \omega_2) = \lim_{T \rightarrow \infty} E[S_{xxy}(\omega_1, \omega_2, T, \kappa)]$$

and the quadratic response function $H_2(\omega_1, \omega_2)$ is given by

$$H_2(\omega_1, \omega_2) = \frac{S_{xxy}(\omega_1, \omega_2)}{S_x(\omega_1) S_x(\omega_2)}$$

in which $S_x(\omega)$ is the wave energy spectrum.

This is a standard text book method, and first applied by Borresen of Norway [1] to moored structures. However, the latter approach meets difficulty in calculating the mean force operator $H_2(\omega_1, \omega)$ i.e. the response along the \mathcal{R} axis of Fig.16 of the Committee Report. We are at present reverting back to Dalzell's method [ref. 186] to find whether the limiting value computed by the direct FFT method with $|\omega_2|$ approaching ω_1 , corresponds to that of Dalzell's method.

From the works so far conducted, we feel that the functional expression approach is one that shows good promise for treatment of non-linear system responses, and suggest that the Committee make an effort to survey more actual analysis on ship and structures done along that line. We are also of the opinion that the unavoidable slight reflections of long waves from the beach, and the scatter of waves by the ship itself might be better overcome, at the present state-of-art at least, by dealing with quadratic response functions rather than by stressing on the accurate reproduction of wave spectrums uncontaminated in any way by reflections and setting down.

N.H.NORBIN - Swedish Maritime Research Center, Göteborg, Sweden

The Committee is to be congratulated to a fine piece of work in its review of the problems and state of art in this challenging field. I will briefly comment on the alternative potentials

offered by many new and unconventional testing facilities, which are dedicated to problems of ships and ocean engineering objects alike. In the design of the Maritime Dynamics Laboratory we judged it necessary and proper to limit the maximum depth, for seakeeping wave experiments, n.b, to 3 m in order to fully exploit the advantages of the variable depth capabilities of the wave makers, benches and the computer-controlled multi-motion carriage system. Whatever design philosophy was applied for the facility, however, there remains a need for careful design of the individual experiments, and in that context we all have a responsibility to our clients, who may be less aware of the fundamental phenomena in their problem area. When the synthesis of experimental results may fit into computer simulation the use of large model elements has considerable advantages, but every opportunity must be taken to verify the system behaviour by model or full scale experiments. In other cases it may be possible to extend the nominal capabilities of the experimental facility by means of special arrangements. As examples of structure element testing I will mention steady-flow force measurements on a two-dimensional section of a jack-up leg, mounted between end plates in the high-speed section of the No 2 Cavitation Tunnel. Incipient cavitation limited the water speed to some 14 m/s, in which case the 4 kN balance was still not overstrained. The records did indicate, however, that supercritical conditions were experienced in the upper range of speeds tested, and certainly so for main vertical members.

Another example may be given by oscillator tests with a full-scale element of a riser pipe, attached to a special balance on the MDL carriage, which was programmed to duplicate ocean wave particle time histories. Here transient forces amounted to some 15 kN. The tests were made to validate theoretical prediction methods in use, and we hope that it

will be possible to release some of the results at another opportunity.

To meet the needs for deep-water riser model testing we have recently arranged a narrow pit in the basin floor, extending the local depth to 7.5 m. Special mooring systems may require the simulation of a wider deep - water area. On page 310 of the Report it is pointed out that the horizontal limits of a model basin may be virtually removed by the use of non-linear springs in the chain system. In the same way the depth of the basin may be virtually increased by various special arrangements. A combination of the deep-depth pit in the basin floor and position-and-attitude controlled moorings outside the pit is furnishing a new potential.

A.M.FERGUSON, University of Glasgow,
United Kingdom

I thank the Committee for a useful and interesting report.

In common with most people present I spend a great deal of time testing models of offshore platforms. I can therefore well aware of the scaling problem associated with groups of surface piercing cylinders etc. However, in the real life of rig operation there is the more pressing problem of rig safety. We should not wait until the next rig disaster before conducting research to answer some relevant stability problems.

Two such questions come to mind:

- a. Is there any further research planned or recommended into the tilt phenomenon which affects most semisubmersibles at particular wave frequencies?
- b. Does the Committee consider that more research should be carried out into the effects of mooring systems (intact

and damaged) on the stability of floating platforms or are the modelling problems too great? On the same theme would it be practical to have continuous monitoring of platform G.M., on site, by regular inclining experiments with mooring attached?

S.SCHUSTER - Versuchsanstalt für Wasserbau und Schiffbau, West Berlin

At first I may congratulate the committee for its outstanding report summarizing a lot of helpful information. It's true, information is the first step to any research and, vice versa, the research is hindered if there is a gap in the information. You are right when pointing to such a gap by your first recommendation. If you ask for more descriptions of the full size environment, I may remind about the same efforts of ECOR, where the committee's chairman and I have the honour to be council members.

Taught that data collecting on waves, currents, wind, salinity and so on not being matter of the engineers but of the oceanographic scientists, we asked them and learned that their organisation IOC, the Intergovernment Oceanographic Commission in the frame of UNESCO, had not known up to now how important their knowledge would be for us. Few weeks ago at the tenth session of IODE, an especially in view of data exchange constituted working group of IOI where I represented ECOR, we were informed on its RNODC - Programme, which is collecting and collating all the data measured by the dif-

ferent national bodies. Contacts between the ECOR President Goodfellow and the Programme managers Dr. Flemming, U.K., and Dr. Wilson, Canada, are prepared. Besides we should continue in getting wave data by our colleague Hogben functioning as a kind of link between the different organisations.

I hope that, via ECOR, some questions referring the Committee's first recommendation will be answered in the near future.

B.JOHNSON - United States Naval Academy, Annapolis, Maryland, USA

Relative to the discussions of Prof. Schuster and the reply of Dr. Yamanouchi I offer the following comments. I believe that the Towing Tank community must develop experimentally verified wave analysis parameters for the description of extreme wave and wave group phenomena. By neglecting this task, we can only expect that the oceanographers will continue to measure and analyze wave height and period statistics that average out the important characteristics of such waves. I strongly encourage the Ocean Engineering committee to undertake the identification of parameters such as those mentioned in my state of the art report on irregular wave analysis which will adequately characterize breaking wave and wave group phenomena. This may require that the oceanographers develop directional arrays of specific geometries so that new parameters can be obtained from the resulting wave records.

11. REPLY OF THE COMMITTEE

In replying to the first point raised by *Dr. Huse* it shall be stated that it is obviously true that responses at or near to resonance frequencies are strongly dependent on the damping. Therefore one must expect a large influence on measured values in a case where the frictional damping of the measuring system becomes large relative to the damping of the tested configuration. We thank you for the additional remark which was overlooked in the final version of our report.

The second point deals with the structural damping of SPM hawsers. It was not the intention of the report to suggest that structural damping is always important in case of hawsers. We only wished to point out that in any situation the relative magnitudes of hydrodynamic and structural damping should be investigated, and if the latter is important then naturally an attempt should be made to model it.

As to the use of a computer controlled winch, the committee agrees that this is a very powerful tool (see our section on hybrid models). However we think that in some cases (for example T.L.P. mooring tethers) the required frequency response of the winch would be excessive.

In the third point it is suggested that we should add presentation and reporting to data acquisition and analysis as a topic for standardization. However, one must remember that ocean engineering covers a wide range of completely different types of model tests with different demands for analysis and presentation. The committee believes that it is too early to consider standardization of presentation when we have not yet started on analysis.

Also we feel that this task could fall within the area of the Information Committee.

The Ocean Engineering Committee has addressed the problem of wind action on ocean structures. In the recommendations it is said that emphasis should be placed on the varying of the wind speed because of the important effect that low frequency ($\sim 1/2 - 2$ min) wind speed variations can have on the response of certain offshore systems. It is realized that wind tunnel testing would be a very helpful tool to obtain the wind forces on different types of ocean structures.

Dr. Treshchevsky also addresses the problem

of wind gusts in a higher frequency domain ($\sim 0,5-1$ Hz). Wind gusts in this frequency domain would be most important for the design of different structures on a platform, say a derrick tower. It is realized that this aspect is very important. The Ocean Engineering Committee has addressed the problem of vibrations in the same frequency domain of structural members in water and it is also realized that wind tunnels are used to study vibration phenomena related to structures in water.

However, the Ocean Engineering Committee has felt that it would be outside its scope of work to address the wind tunnel testing technique and the wind force problems related to the wind gusts in the frequency domain around approximately 1 Hz.

Wind tunnel testing is, as Dr. Treshchevsky rightly points out, relevant to the work of several ITTC Committees, since several ITTC members work with wind and wind loads, we feel that it should be an ITTC policy decision whether wind and wind tunnel testing should be included in the consideration of ITTC work to a larger extent than it is to day or not.

The committee congratulates *Dr. Tachibana* and *Dr. Reis* on their oceanographic and environmental data acquisition project for Brasil offshore developments.

Any additional weather and environmental data is welcome as it must eventually lead to increase in the safety of construction and operation of offshore systems.

We understand that the wave data will be processed to a few parameters that will be stored on magnetic tape and transmitted onshore twice a day.

If so, we suggest that you consider in addition a system where you can save parts of the time series or history when for instance the significant wave height

exceeds a certain preset limit.

Such time series data would be very useful for future studies of for instance wave grouping phenomena which especially affect low-frequency response of floating structures.

The committee would like to receive further information on the following points:

1. To what extent is the oceanographic measurement program coupled to hindcast studies of waves?
2. On which basis have you chosen 7 years as an operation period?
3. What is the cost of the system?

The committee thanks *Prof. Takezawa* for his contribution describing his experience with an optical position measuring system.

We would however like to know a little more about the principle of operation of this system, and in particular the resolution and range of the camera detector.

We note the success that Professor Takezawa has found in measuring the motions of the semi-submersible in head or beam waves, and we agree with him when he describes the difficulty experienced with more complex motions.

In our report we alluded to the difficulties of using the optical systems for a general position measurement system in all six degrees of freedom, and Professor Takezawa evidently agrees with us.

In practice, where many different types of tank model are to be tested under a wide variety of conditions, it is not always possible to position the camera detectors so that geometry errors are small. In general it is also necessary to have redundant target LEDs so that one or more may pass out of sight of the cameras, or move into geometrically unfavourable positions without loss of

position information. These problems require real time data processing to solve the geometry and optimise the model position and attitude. This in practice means the use of a dedicated minicomputer on the front end of the data acquisition system. It is this requirement for hardware and software that makes such a system expensive.

Finally I can add a few notes on the properties required for an "ideal" optical system. They are by no means complete.

1. Sufficient camera resolution/accuracy to enable adequate measuring accuracy even when the camera field of view is not being fully utilised.
2. Adequate range for large tanks (say 100 m).
3. Real time processing hardware/software to:-
 - (a) Eliminate image reflection problems.
 - (b) Make best use of redundant information.
 - (c) Solve geometry analysis.
 - (d) Handle several models simultaneously.
4. In setting up an experiment it should be unnecessary to:-
 - (a) Accurately survey camera position.
 - (b) Have truly perpendicular field of view.

I would go on at length, but I won't!

It is clear that systems like SELSPOT have few of these properties, whilst the new system described by NHL has at least some.

We await future developments in this field with interest.

Dr. Kim would like to have our suggestion to overcome scaling problems related to drag forces and damping. We can only regret that we do not have a ready made solution.

At the present state of the art we should not rely entirely on model test results

applying the Froude model law for drag dominated structures. The test results should be adjusted with a view to the knowledge we have on C_D and C_M values in different regimes of the Reynolds number and the Keulegan-Carpenter number. In spite of this weakness of testing drag dominated structures we think you still can obtain from model tests useful knowledge about a complete drag dominated structure.

As an example of such a test we can briefly mention a model test program that was started at the Norwegian Hydrodynamic Laboratories on a guyed tower. This is a slender jacket type structure standing on the sea bed supported horizontally by guylines anchored in the sea bed.

The objective of the model test program is to compare model test results with a computer program. The model is simplified compared with a real structure and is considered to be on scale 1:1. However, as far as reproducing vibration periods of the structure a scaling ratio of 1:50 has been chosen. The model will be in 7 meter water depth.

We have a fair idea of what the C_D and C_M values will be in the regime of the model Reynolds and Keulegan-Carpenter numbers. If the model results and computer program results compare satisfactorily well we can adjust the C_D and C_M values to the full scale regime of Reynolds and Keulegan-Carpenter numbers. If the results do not compare satisfactorily we have to look for reasons for the discrepancy.

In reply to *Prof. Gu*, the Committee notes a few points that are not clear in his contribution, however, the ocean engineering committee believes that the method mentioned to obtain the cross-bispectrum as the product of Fourier Inversion of input and output should give

us the same results with that by Dalzell's method, that is through the 3rd moment cross-correlation functions. This is just a matter of computing techniques. Volterra's functional expression is good to show the structure of the non-linear output, but has nothing to do with the computing procedure. If we assume the quadratic response, then the functional expression gives us clearly the relation of response function with the cross-bispectrum of input and output.

However, when we use the F.F.T., we have to be very careful in using the smoothing procedure, as was pointed out in Dr. Yamanouchi's contribution to the Seakeeping Committee Report during this Conference.

We quite agree that we have only a few examples of this kind of analysis published, and only a few have experience in this field. We need a good accumulation of this kind of experience before we can recommend something on this kind of analysing method.

The Committee agrees with you that undesired disturbances of test results due to model and beach reflections, basin oscillations or any other unrealistic low frequency waves generated in the tank could be overcome to a certain extent by a proper method of analysing the test data. Nevertheless we feel that we should still take due care in generating waves in a test facility, in order to minimize unwanted effects as much as possible.

Firstly the committee would like to thank Dr. Norrbin for his kind opening remarks.

Dr. Norrbin is correct in pointing out that there are several new and unconventional test facilities that can be used for ocean engineering model test work. Examination of tables 1 - 5 of the report reveals this.

We wholeheartedly agree with the point about the need for careful design of individual experiments and would add that it is the responsibility of the tank to point out to the client the various limitations of the test being carried out.

As noted in section 2.3.4. of the report the model testing of separate components of a system is an important technique which in some cases enables models to be simplified and scale effects to be overcome. However, it has to be remembered that one may only use such techniques when one has a theory that enables the results of the individual tests to be "reassembled" into a result for the whole system.

The measurements made by SSPA on board a jack-up leg section and a riser pipe section are of great interest and we hope that they will soon be published. However the use of a device such as the MDL carriage can never fully simulate the complex water particle motions experienced in a real wave. In a wave a riser pipe experiences a varying orbital velocity field along its length, as well as flow field related to its own deflections.

Having said this however, such results and full scale measurements in the ocean, play an important part in the understanding of these complex flows, and the scale effects we experience in our tanks.

It is time that one may simulate the presence of deep and wide parts of mooring systems, and thus allow model tests to be carried out in a tank of limited width and depth. We noted in the report the various techniques or "tricks" that can be used. However, such simulation, whether achieved by physical or numerical modeling, can only be carried out when the behaviour of the system being simulated is fully understood. This is not always the case, an example being perhaps a mooring system

which is affected in its response by the direct hydrodynamic action of waves and current.

The committee would suggest that one may be reasonably confident of such simulation techniques when the tank depth and width are sufficient to ensure that true physical modeling of the underwater parts may at least extend to beneath the zone of wave action.

The committee thanks *Dr. Ferguson* for his stimulating comments and questions.

In the limited space of our report we did little more than mention the problems of stability, and the tilt phenomenon is simply referred to on page 332. These are just examples of the many topics in ocean engineering that there was insufficient time or space to permit adequate discussion.

On the general question of stability the committee agrees that there is much work that can be done. The committee is aware of the work of SNAME panel MS3 which has been looking at this problem, and has for example carried out wind tunnel tests to investigate the aerodynamic overturning moments.

The effect of intact mooring lines on stability and response is of course effectively covered in most model tests of floating platforms, but the damaged case is often not treated. There are two separate aspects to this latter case. Firstly the steady state response of the structure when a mooring cable is missing, and secondly the transient behaviour that occurs when a cable parts.

Both are areas where perhaps more attention should be given to general research, and detailed investigation of specific designs. There will obviously be modeling problems in the transient case, but they

should not be insurmountable.

Finally the continuous monitoring of G.M. would obviously be a great safety feature for floating platforms. Model tests should be ideally placed to try and solve this intriguing problem elegantly, and prove the solution's validity on the model scale.

Thank you very much *Prof. Schuster* for your comments on the environmental data, related to our recommendation I. Of course this recommendation is not meant to suggest that ITTC itself should collect the environmental data, but we suggest to obtain the data through appropriate sources.

There are so many international, national, governmental, non-governmental organizations related to the acquisition of the oceanographic environmental data, that could be asked to supply this kind of information.

The Committee agrees with *Prof. Schuster* that ECOR could be a source for the environmental data. ECOR is a non-governmental international body that is composed of 8 or 9 national committees of maritime countries as W. Germany, the Netherlands, Norway, UK, USA, and Japan and also 5-6 international marine-related engineering organizations.

We remember that during the 13th ITTC, a proposal that ITTC should join this ECOR was made by *Prof. Schuster*, but this was not agreed. ISSC has been one of the active members from the time of establishment and contributing significantly through *Dr. Hogben's* efforts.

Now the Committee believes that not only ECOR, but also many other organizations could be asked to assist us on this problem.

The Committee thanks *Prof. Johnson* for his comments. We agree with Prof. Johnson that we, as representatives of the engineering community, should specify our needs to the oceanographers. In this respect, ECOR could probably play a role as a coordinating body. Within ECOR there is much interest in wave directionality at the moment. As many of you probably already know, ECOR will co-sponsor with the American Society of Civil Engineers an international Symposium "Directional Wave Spectrum Application '81", which will be held in Berkeley, Cal., U.S.A. directly after this Conference.

Answer to the Committee by Mr. Reis

1. The data to be relayed by satellite to the San Paulo onshore base relates exclusively to information on reliability of the system. The environmental data will not be interrupted for these transmissions. The sampling rate, duration and interval of the environmental data are shown on Table 1 of the written contribution.
2. The total time span for operation of the whole system is not defined. The first tentative schedule is to do it for 7 years, but only experience will help deciding the needed time span for each point.
3. No cost data are available as of now.